Phys 131 2016

Lecture 2

Syllabus: My office is WS 228 B

~~Tu~~ Wednesday: * Discussion / quiz

Supp Ex 1,2,3

Ch 2 CQ 4, 6

Prob 1, 2

* Do before class
* Bring to class
* No turn in.

* 10 minute quiz at end
  - counts {5pts} (out of eventual 600pts)
* Just as important for learning as HW

Friday Warm Up 1 (D2L) (by 8am)

* reading exercise
* show D2L page → more details on Wednesday.
* Lecture

Thursday LABS WILL MEET.

Diagnostic Test : - Average 38%

- Will cover this type of material during semester.

Motion

Consider an example of the motion of an object

Demo: PhET Projectile Motion

- fixed initial conditions
- fire cannonball/object
- animation records position as time passes

The general question in physics is:

> Given various objects in a known initial state (of motion) at one instant and some knowledge of how they interact, what will their states of motion be at any later instant.

This question includes:

1) kinematics – describing state of motion
2) dynamics – describing how state of motion changes.

We shall start this course by developing the conceptual and mathematical language for describing how motion happens (not why it happens). This is kinematics

Kinematics: Position

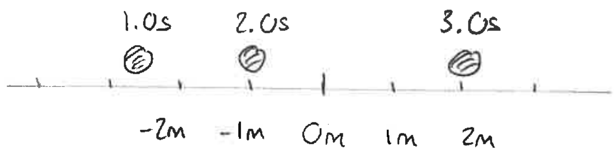
There are two basic notions in kinematics

1) position
2) time (measured in seconds (s))

To simplify the discussion, we consider an object that can move back + forth along one straight line. This is one-dimensional motion

One procedure for representing such motion is:

Observe object moving against a fixed axis (units of meters (m))



motion diagram

$\rightarrow$ Produce data table

time, t in seconds	position, x in meters
1.0s	-2.5m
2.0s	-1.0m
3.0s	2.0m

To understand this mathematically one can construct a graph of position versus time

Demo: PhET Moving Man

$\rightarrow$ Charts tab

$\rightarrow$ initial $v=2$, $x=-6$ $\rightarrow$ remove v graph

$\rightarrow$ run + use playback

Quiz!

Kinematics: Velocity

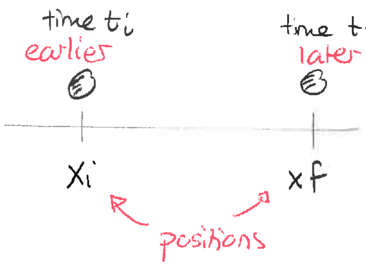
For the previous moving man demonstration, it is more economical to describe the motion in terms of the rate at which position changes (rather than a table of positions versus times). One conventional notion that might do this is speed which is the rate at which distance is covered. But, in physics, this is inadequate and the preferred concept is:

$$\boxed{\text{velocity} = \text{rate of change of position}}$$

The animation shows that if the initial position + velocity are known then it could be possible to calculate the position at later times.

would be possible to calculate the position at all times.

To create a mathematical quantity from this we start with a preliminary crude definition



Observe the object at two instants ["initial" and "final"]. The <u>average velocity</u> over this time interval is

$$V_{avg} = \frac{\text{change in position}}{\text{change in time}} = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i}$$

Note: 1) Δ means "change" - don't cancel these in the definition

2) units: m/s

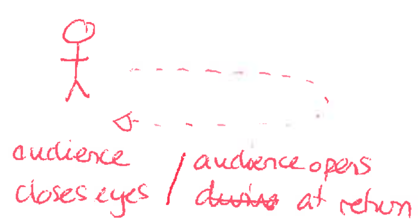
Quiz 2

Quiz 3

This illustrates:

1) average velocity looks at the overall change in position over an entire interval + ignores the details during the interval.

Demo: Move as



2) average velocity has a sign

V_{avg} positive $\Leftrightarrow$ overall displacement to right

V_{avg} negative $\Leftrightarrow$ " " to left

3) velocity + speed are different. For example an object that moves + returns to its initial position has a zero average velocity but non-zero speed

Also speed is always positive

Uniform motion

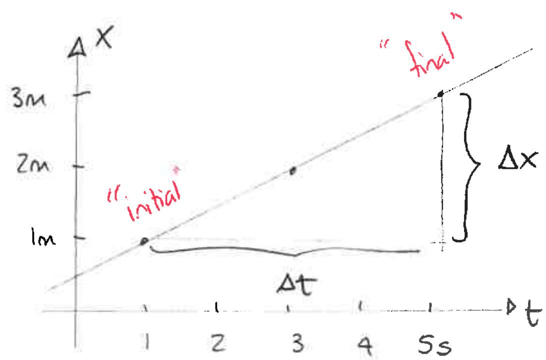
In the animation the man moved in the same direction at a constant speed. This is called uniform motion. For uniform motion:

1) the average velocity is the same over any interval
2) the speed of the object is the absolute value of the average velocity (ignores the sign).

One can show:

For uniform motion a graph of position versus time gives a straight line and

average velocity = slope of position versus time



Since

$$V_{avg} = \frac{\Delta x}{\Delta t}$$

is true regardless of the time interval we get

$$\Delta x = V_{avg}\,\Delta t \Rightarrow x_f - x_i = V_{avg}\,\Delta t$$

and thus

earlier position

For uniform motion: $\boxed{x_f = x_i + V_{avg}\,\Delta t}$ time elapsed between earlier/later

later position   average velocity.

This is not true for non-uniform motion (velocity changes) but if the velocity takes on a succession of constant values then one can use this in a piecewise fashion.